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THECAMOEBIANS (*TESTACEOUS RHIZOPODS*) FROM A TROPICAL LAKE: LA FE RESERVOIR, ANTIOQUIA, COLOMBIA

Rizópodos testáceos (tecamebas) en la Represa La Fe, Antioquia, Colombia

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ABSTRACT

This research describes thecamoebians and explores their utility as environmental bioindicators on La Fe Reservoir, Antioquia, Colombia. Nineteen dredge samples were collected at the sediment-water interface, with a cylindrical dredge in March and October 2001. Temperature, pH, conductivity and total dissolved solids were recorded *in situ* both at depth and at surface for each sample locality. Counting of thecamoebians was done in the >63µm size fraction until 200 thecamoebians per sample were identified. A total of 6 genera, 14 species and 25 sub-species were found at La Fe Reservoir. *Arcella vulgaris* and *Centropyxis aculeata* dominate most of the samples. This study opens the possibility for additional research with thecamoebians as bioindicators of limnological physical parameters in tropical water bodies and calls for a further explanation for the occurrence of *A. vulgaris* and *C. aculeata* as the dominating species on this tropical reservoir.

Key words. Bioindicators, Thecamoebians, Tropical Reservoir.

RESUMEN

Se realiza un inventario de los rizópodos testáceos (tecamebas) del embalse La Fe y se explora su utilidad como bioindicadores ambientales en aguas continentales tropicales. Diecinueve muestras de sedimento fueron colectadas en marzo y octubre de 2001. Se registraron en cada sitio de muestreo la profundidad y las variables físicas: pH, temperatura, conductividad y sólidos totales disueltos (TDS), tanto en superficie como en profundidad. El conteo de las tecamebas se realizó en la fracción >63µm hasta que un total de 200 tecamebas por muestra fueran identificadas. Un total de seis géneros, 14 especies y 25 subespecies fueron encontradas en el embalse La Fe. Las especies *Arcella vulgaris* y *Centropyxis aculeata* dominaron la mayoría de las muestras. Este estudio abre la posibilidad para investigaciones posteriores utilizando las tecamebas como bioindicadores de parámetros físicos ambientales en aguas continentales tropicales e invita a estudios posteriores para explicar la dominancia de *A. vulgaris* y *C. aculeata* en este embalse tropical.

Palabras clave. Bioindicadores, Embalse tropical, Tecamebas.

INTRODUCTION

"Thecamoebian" is an informal term used to characterize a special group of testate prototists (agglutinated or autogenous) that belong to the Subphylum Sarcodina. Thecamoebians thrive in lakes, streams, rivers, ponds and brackish water and are preserved as fossils in Quaternary deposits (Medioli & Scott 1988). A test, in the form of a bag or sack with one orifice (two in few genera) for the emergence of filose or lobose pseudopodia characterizes these organisms. Pseudopodia allow them to move and capture food. An identification key for Holocene lacustrine thecamoebian taxa (Kumar & Dalby 1998) can be found at Paleontologia Electronica (http://palaeo-electronica.org/). Even though thecamoebians fossilize easily and are readily recovered from sediments by standard micropaleontological techniques, they have not been studied extensively. Thecamoebians have an advantage over other microfossil groups because: (1) they are excellent environmental and paleoenvironmental indicators, (2) sample preparation is simple, fast and inexpensive and (3) they are abundant and therefore amenable of statistical treatment (e.g. McCarthy *et al.* 1995, Reinhardt *et al.* 1998).

Thecamoebian researchers over the last 100 years have explored the geographic distribution and taxonomy of thecamoebians (e.g. Leidy 1879, Ogden & Hedley 1980, Charman 1999), as well as their use as environmental and palaeoenvironmental indicators (e.g. Charman *et al.* 1998, Reinhardt *et al.* 1998, Kumar & Patterson 2000). Assemblages of different thecamoebian species and subspecies (morphovariants) have been used as bioindicators of: sea level change (e.g. Charman *et al.* 1998), limnological variables, such as temperature, pH, oxygen concentrations and heavy metal content (e.g. Patterson & Kumar 2000) and for palaeohydrology and paleoclimate studies (e.g. Charman & Warner 1997).

Aside from the study of thecamoeabians from Sentani Lake (Indonesia), where arcellacean assemblages and limnological variables were correlated (Dalby *et al.* 2000), no other ecological study is available from tropical latitudes. Investigations done on tropical lakes (e.g. Green 1975, Cerda 1986) describe thecamoebians taxa but pay little attention to the environmental controls on their distribution. Colombian Reservoirs have been intensively studied with respect to several environmental variables, as well as micro invertebrates and plankton, (e.g. Castaño & Palacio 1999, Roldan 2000, Ramírez *et al.* 2000), thought published data from La Fe Reservoir are scarce (e.g. Vega *et al.* 1992, Roldan 1992). Therefore, the primary purpose of this note is to document the thecamoebian taxa from la Fe Reservoir and compare it with ecological studies done in temperate latitudes. Although several thecamoebian genera are consistently found in Bogota`s high plain sediments (Hooghiemstra, 1984) this would be the first work on thecamoebians as environmental indicators in Colombia.

LA FE RESERVOIR, SAMPLING AND LABORATORY PREPARATION

La Fe Reservoir, with a surface area of 1.39 km^2 and a maximum water depth of 20 m, supplies drinking water to the municipality of Medellín. La Fe Reservoir is located on the Central Cordillera of Colombia (6º6`57``N to 6º6`00``N and 75º30`30``W to 75º29`36``W) at an altitude of 2156 m.a.s.l. (Vega *et al.* 1992). Water inputs are slightly contaminated with domestic sewage from El Retiro village and nearby farms (Medina 1983). Nineteen surface sediment samples were collected with a cylindrical dredge in March and October 2001. Temperature, pH, conductivity and total dissolved solids were recorded *in situ* both at depth and at surface for each sample locality. Thecamoebians were separated from sediment samples by gentle washing in a 63 µm sieve, and then manually picked under a binocular microscope.

THECAMOEBIAN ASSEMBLAGES AT LA FE RESERVOIR

A total of six genera, representing fourteen species and 25 morphovariants were found at la Fe Reservoir (Table 1). Most of the samples are dominated by *Arcella vulgaris* (Ehrenberg 1830) and *Centropyxis aculeata “aculeata”* (Ehrenberg 1830). Faunas similar to those found in La Fe Reservoir are found in Sentani Lake (Dalby *et al.* 2000), coastal lacustrine areas (Patterson *et al.* 1985) and stressed lacustrine environments in temperate regions (e.g. Patterson & Kumar 2000, Reinhardt *et al.* 1998). Nonetheless, a greater number of taxa were found in La Fe Reservoir that in Sentani Lake.

Distribution of a stressed arcellacean fauna (dominated by *C. aculeata* and *A. vulgaris*) from Lake Sentani (Indonesia) is explained by the feeble stratification of the lake (Dalby *et al.* 2000). By contrast, *C. aculeata* and *A. vulgaris* dominate in almost all samples from La Fe Reservoir, including shallow and coastal locations, were anoxic conditions are absent. Cores from lakes in the coastal areas of New Brunswick (Canada) also present a similar fauna to La Fe Reservoir apparently representing transitional episodes from marine to freshwater conditions (Patterson *et al.* 1985). Because salinity is very low in La Fe Reservoir, a further explanation is needed for the occurrence of *A. vulgaris* and *C. aculeata* as the dominating species on this tropical lake. *A. vulgaris* and *C. aculeata* are also known to inhabit stressed environments such as lakes with high levels of heavy metal contamination or brackish conditions (e.g. Patterson & Kumar 2000, Patterson *et al.* 1996). Even though there are no water chemical analyzes on heavy metals in La Fe Reservoir, contamination is unlikely given that only slightly polluted waters are discharged into the reservoir and that the final use of water is for human consumption. Kummar and Patterson (2000) used *A. vulgaris* as an indicator of pH variations on temperate lakes. At James Lake, northeastern Ontario (Canada), *A. vulgaris* is the dominant species in areas where pH is <5.5, but displays low abundance or disappears where pH values range from 6.5 to 7.5. Nevertheless, *A. vulgaris* is a principal component of the “La Fe” arcellacean fauna where no pH values lower than 5.4 were reported. These contrasting results point to indicate that *A. vulgaris* responds to pH differently in temperate and tropical environments.

Other species that are used as indicators in temperate lakes such as *Difflugia oblonga* (Ehrenberg 1832) and *D. protaeiformis* (Lamarck 1816) were also found at La Fe Reservoir. *D. oblonga* and *D. protaeiformis* have been reported from sites with high organic content (Patterson *et al.* 1996). These two species were found in several samples both in March and October. *D. urceolata “elongata”* (Carter 1864) is an opportunistic early colonizer species, whereas *Cucurbittella tricuspis* (Carter 1856) has been reported in eutrophic waters (Patterson *et al.* 1996). *D. urceolata “elongata”* was found in samples collected from low depths and near river outlets at La Fe Reservoir. *C. tricuspis* was found in coastal zones and at places with water rise levels and high quantities of solid residues.

Table 1. Thecamoebian occurrences in samples from La Fe Reservoir. Samples were quantitatively analyzed and are recorded as percentage abundances. Temperature, pH, conductivity and total dissolved solids (TDS) for each sample are also indicated for both march (M) and October (O). All samples were collected at 6º6`N and 75º30`W.

	1		2		3		4		5		6		7		8		9		10	
	M	**O**	**M**	**O**	**M**	**O**	**M**	**O**	**M**	**O**	**M**	**O**	**M**	**O**	**M**	**O**	**M**	**O**	**M**	**O**
Environmental data																				
Latitude	34``	35``	50``	50``	50``	50``	28``		22``	22``	23``	22``	48``	49``	52``	53``	55``	53``	51``	51``
Longitude	12``	10``	09``	08``	09``	08``	13``		18``	17``	08``	09``	04``	05``	05``	05``	04``	09``	01``	00``
surface pH	6,5	7,5	6,5	7,4	6,3	7,4	6,2		6,4	7,7	6,7	7,5	5,9	8,2	6,6	8,3	6,3	8,1	6,1	8,6
depth pH							6,0				6,5	7,5	6,3	7,1	5,9		6,3	8,5	6,2	8,4
surface temperature (°C)	21,5	23,7	17,4	22,1	16,9	20,7	24,7		21,4	19,9	22,8	23,8	18,7	23,0	18,9	25,4	19,1	26,3	19,1	27,7
depth temperature (°C)							21,9				22,0	24,4	17,1	22,8	18,3		17,4	26,3	18,2	27,6
surface conductivity (mS)	55,0	83,2	78,2	110,1	74,8	85,9	47,9		48,8	35,1	51,6	47,8	72,1	65,5	56,7	54,7	52,5	62,6	44,3	74,6
depth conductivity (mS)							82,1				48,5	50,3	77,3	322,0	49,2		56,7	53,3	52,2	50,1
surface TDS (mg/l)	28,1	41,7	39,5	55,4	36,9	43,3	24,0		25,7	17,6	25,7	23,9	35,9	33,0	27,9	27,5	25,9	31,4	21,4	37,4
depth TDS (mg/l)							36,4				23,4	25,1	38,7	164,0	24,1		30,2	26,8	25,7	27,2
thecamoebians counts																				
Arcella vulgaris	42,8	26,4	9,9	19,8	15,9	16,6	2,4		38,6	35,5	29,8	37,3	36,6	40,1	36,6	27,7	35,4	14,8	29,7	46,9
Arcella dentata				2,4	1,0	1,5						0,5	1,0				1,0		0,5	
Centropyxis impressa		3,0	1,5	0,9	1,9	2,4	2,9							0,5						
C. aculeata "aculeata"	47,3	38,3	31,0	49,5	41,3	50,2	3,9		44,9	36,9	31,7	23,9	60,9	44,6	48,0	24,3	56,0	22,7	64,6	37,0
C. aculeata "discoides"				0,5					1,4	4,9	3,4	6,5	0,5	5,9	4,0	1,0	0,5	0,5	2,4	0,5
C. constricta "aerophila"			2,0																	
C. constricta "constricta"						0,5														
Lesquereusia spiralis	0,5								1,9	3,0	2,9	1,0								0,5
Nebella collaris																0,5	0,5	0,5		4,7
Cucurbitella tricuspis		0,5	30,0	7,5	15,9	1,5				3,0						1,5				0,9
D. protaeiformes "amphoralis"	0,5	0,5							0,5								1,4	4,4		
D. protaeiformes "claviformis"		0,5			1,4	2,0			4,3		1,0	1,5			0,5	0,5	1,9			
D. protaeiformes "acuminata"	8,0	4,5	0,5	0,5	0,5					2,0		7,5		1,5	1,0	16,8		3,0		
D. urceolata "urceolata"		6,0					3,4			2,0	1,0	0,5				0,5				
D. urceolata "elongata"		2,0			0,5					2,0	1,5					2,0		2,5		
D. oblonga "lanceolata"	0,5		1,5			1,0			0,5			3,5		0,5				0,5		
D. oblonga "linearis"	0,5	2,5	3,9	1,4	1,9	7,3	17,6		0,5	5,4	0,5			3,5	3,5	12,4	1,9	47,3	1,0	4,7
D. oblonga "oblonga"		11,9	5,9	8,0	14,9	3,9	58,0		2,9	2,5	23,9	7,5	0,5		1,5	1,5				4,3
D. oblonga "tenuis"		1,5	12,8	0,9	1,9	0,5	6,3			0,5	1,5		0,5	1,5						
D. oblonga "bryophila"		1,5		4,7	0,5	8,8	3,9		0,5		1,5	1,0							1,0	
D. oblonga "glans"										1,0		0,5								
Difflugia lismorensis					0,5															
Difflugia corona		1,0					1,0				1,0	1,0			0,5			1,5		
Difflugia sp. Y. (Green, 1962)						1,5	0,5		3,4	0,5		4,5				9,4	1,0			
Difflugia oblonga X.			1,0	2,8	1,9	2,0			0,5	1,0	0,5	3,5		2,0	4,5	0,5	0,5		1,0	0,5
Incerta sp.				0,9		0,5										1,5		2,5		

Three species were found at La Fe Reservoir that have no been reported from temperate lakes. Only one specimen of *D. lismorensis* was found at La Fe Reservoir in all 19 samples. However, *A. dentata* (Ehrenberg 1830), a species considered rare (Green 1963), and *C. impressa* (Daday 1905) were reported in several sample localities during both sampling seasons. These three species have been reported from tropical ecosystems, especially in Brazil and Africa (Green 1963, 1975, Chardez 1964), but always in few places and quantities.

This study opens the possibility for additional research with thecamoebians as bioindicators of limnological physical parameters in tropical water bodies and calls for a further explanation for the occurrence of *A. vulgaris* and *C. aculeata* as dominating species on tropical lakes, questioning their value as heavy metal bioindicators at these latitudes. The potential of thecamoebians as paleoenvironmental indicators of lacustrine and coastal Quaternary deposits is highly promising as a complementary tool in multiproxy studies based on diatoms and palynology.

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